EDC Landsat 7 DHF

Operations Concept

September 1997

U. S. Geological Survey / EROS Data Center

Sioux Falls, South Dakota

EROS Data Center Operations Concept Document for the Landsat 7 Data Handling Facility

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Preface

This document is under the configuration management control of the EDC Landsat 7 Project Manager.

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Abstract

The EROS Data Center Operations Concept Document for the Landsat 7 Data Handling Facility describes the concept for operating the Landsat 7 Ground Station, Landsat 7 Processing System, and the Landsat 7 Image Assessment System. These systems are resident at the EROS Data Center (EDC) in Sioux Falls, South Dakota. The system operational environment, operational scenarios and management structure are discussed.

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Section 1. Introduction

1.1 Purpose

This document describes the operations concept for the Landsat 7 Data Handling Facility (DHF). This operations concept is the basis from which detailed operations and support procedures will be developed.

1.2 Scope

This document describes the DHF objectives related to the Landsat 7 mission. The DHF functional design, system architecture, external interfaces and the manner in with the system will be operated (post-launch) at EDC will be discussed.

1.3 Document Organization and Contents

This document contains four sections and a list of abbreviations and acronyms.

Section 1 describes:

a. The purpose and scope of this document.
b. The organization and contents of this document.
c. The assumptions and conventions used in preparing this document.
d. Other relevant documents.

Section 2 describes the DHF. It discusses the DHF mission and presents a reference architecture. The DHF elements and interfaces to external entities are described.

Section 3 summarizes the functions and processes of the DHF operations.

Section 4 describes the DHF management concept.

1.4 Applicable Documents

The following documents contribute to the definition of the DHF concept of operations to the extent referenced herein:

NASA GSFC, 06419/0001, Landsat 7 Ground System, Critical Design Review, Presentations, April 1996

NASA GSFC, 531-OCD-GS/Landsat 7, Landsat 7 Ground Station (LGS) Operations Concept, Signed, January 1996

NASA GSFC, 560-30CD/0194, Landsat 7 Processing System (LPS) Operations Concept, Review Copy/Revision 2, April 1996

NASA GSFC, 560-1ICD/0794, Interface Control Document (ICD) Between the Landsat 7

Ground Station (LGS) and the Landsat 7 Processing System (LPS) Revision 1, Oct 17, 1996.

NASA GSFC, 514-1ICD/0195, Interface Control Document (ICD) Between the Image Assessment System (IAS) and the Landsat 7 Processing System (LPS), Revision 1, July 29, 1996

USGS EDC, DHF-OPS-002D, EDC Data Handling Facility Operations Support Plan, February 1997

NASA GSFC, 23007638, Radio Frequency Interface Control Document between Landsat 7 and the Space Network (SN), Ground Network (GN) and Landsat 7 Ground Station (LGS)

NASA GSFC, 511-4ICD/0296,Interface Control Document (ICD) Between the Landsat 7 Mission Operations Center (MOC) and the Landsat 7 Ground Station (LGS)

NASA GSFC, N/A, Memorandum of Understanding Between the Landsat 7 Processing System (LPS) and the Landsat 7 Mission Operations Center (MOC),---,October 1995

NASA GSFC, TBD, Landsat 7 Mission Operations Center (MOC) to Landsat 7 Image Assessment System (IAS) Interface Control Document (ICD)

HITS, 209-CD-013-003, Interface Control Document Between EOSDIS Core System (ECS) and the Landsat 7 System, Final, March 1996

NASA GSFC, 430-14-01-001-0, Interface Control Document Between Landsat 7 and the Landsat 7 Ground Network, Final, August 1997

Section 2. Landsat 7 Data Handling Facility Description

2.1 DHF Context

The DHF is located at the Earth Resources Observation Systems (EROS) Data Center and is a portion of the Landsat 7 Ground System. The EROS Data Center is located near Sioux Falls, South Dakota.

The DHF is comprised of the equipment, personnel, processes and management required to perform the mission stated in paragraph 2.2. Specifically, the DHF is comprised of:

a. Landsat 7 Ground Station (LGS)
b. Landsat 7 Processing System (LPS)
c. Landsat 7 Image Assessment System (IAS)
d. DHF Management Office.

Refer to Figure 2-1 which is a top level context diagram for the DHF.

2.2 DHF Mission

The mission of the DHF is to acquire, ingest, process to Level 0R, assess the quality of and pass Landsat 7 ETM+ image data and its associated metadata to the EDC DAAC. In addition, the DHF provides the uplink and downlink services required to perform Landsat 7 telemetry reception, command transmission and two-way doppler tracking.

2.3 DHF Operational Environment

The Earth Resources Observation Systems (EROS) Data Center, located in Sioux Falls, South Dakota is a data management, systems development and research field center of the U.S. Geological Survey's National Mapping Division. The Center was established in the early 1970's to receive, process and distribute data from National Aeronautics and Space Administration (NASA) Landsat satellites. The Center holds the world's largest collection of space and aircraft acquired imagery of the Earth. These holdings include over 2 million images acquired from satellites and over 8 million aerial photographs. The Center is also a major focal point for information concerning the holdings of foreign Landsat ground reception stations and data acquired by other countries' Earth observing satellites.

DHF System Context Diagram

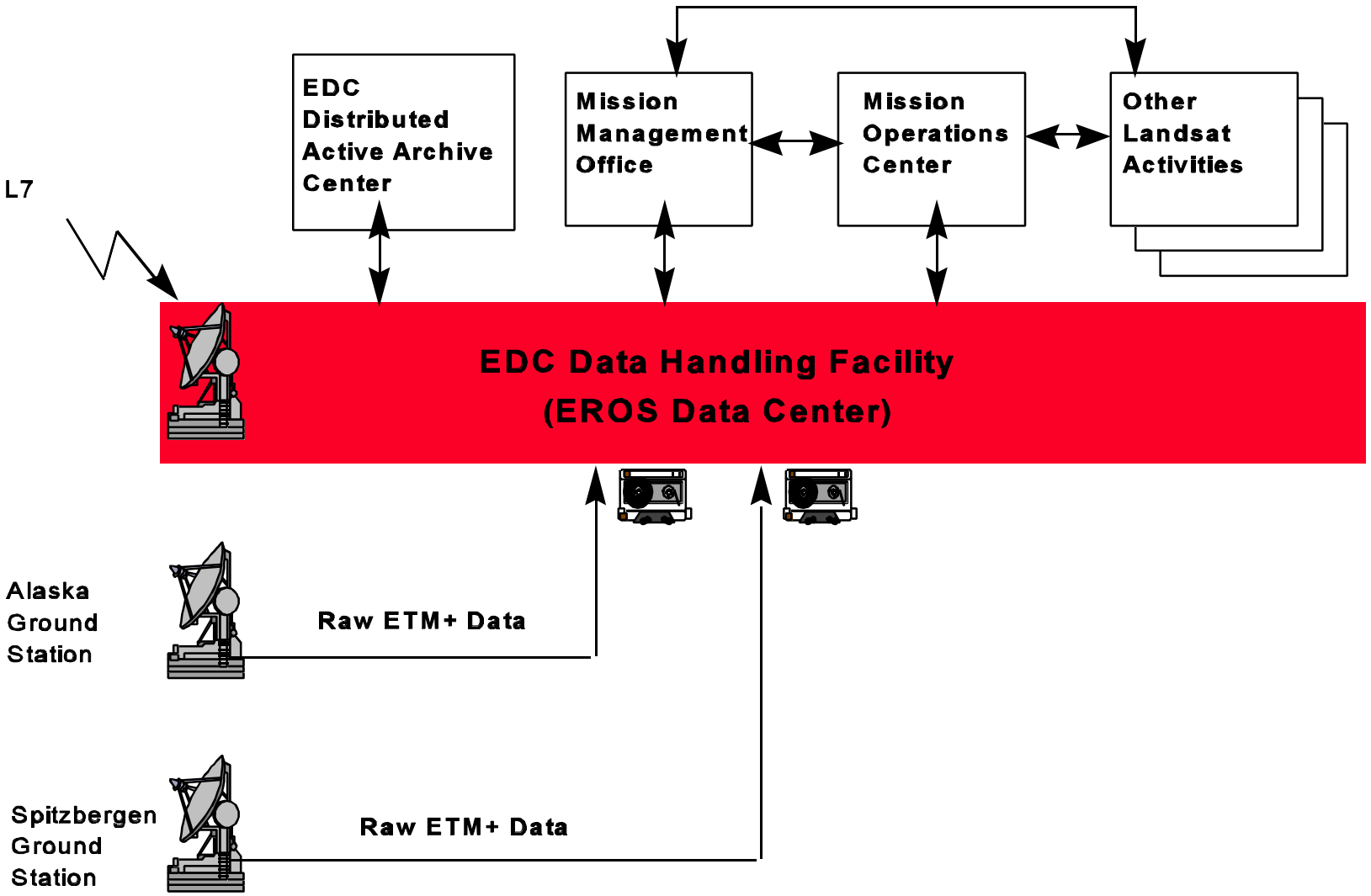


Figure 2-1 Landsat 7 DHF Context Diagram

The EROS Data Center Landsat 7 Data Handling Facility (DHF) was established as part of NASA's Landsat 7 Program to support the reception, processing, archiving and distribution of image data from the Landsat 7 satellite. The Landsat 7 Program is managed cooperatively by NASA, the National Oceanic and Atmospheric Administration (NOAA) and the United States Geological Survey (USGS) and is part of NASA's global change initiative, the Earth Observing System (EOS), administered by the NASA Office of Mission to Planet Earth (MTPE). The DHF will receive Landsat 7 Enhanced Thematic Mapper Plus (ETM+) data via X-band direct downlink and process up to 250 ETM+ scenes per day. The archival and distribution functions are executed in coordination with the EDC DAAC. The EDC DAAC will archive up to 250 ETM+ scenes and distribute up to 100 ETM+ scenes per day. These data will be available to users within 24 hours of acquisition of the image by the EDC Landsat 7 DHF and will be distributed as a Level 0R product.

The EDC facility is approximately 150,000 square feet, including a recently completed 66,000 square foot building expansion. This new addition includes office space, computer rooms, scientific analysis and work areas, an auditorium, conference rooms and also houses the EDC Landsat 7 DHF and the EDC DAAC. The computer room (Refer to Figure 2-2), approximately 9000 square feet, is an environmentally conditioned area with a raised floor and is supplied with electrical power from an Uninterruptible Power System (UPS). Except for the LGS Antenna, the entirety of the DHF equipment is located on the computer floor.

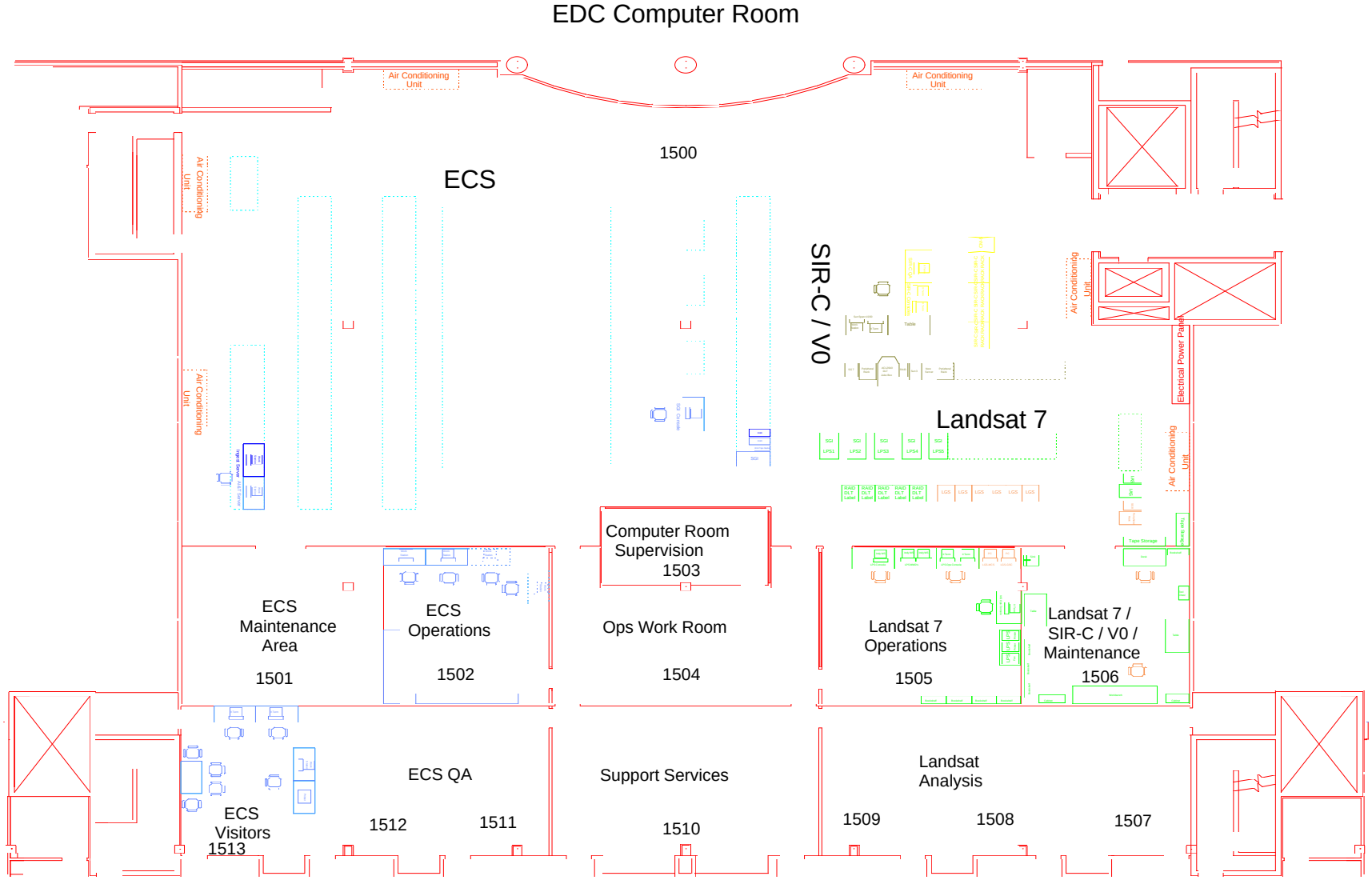


Figure 2-2. DHF Computer Room Floorplan

2.4 Reference Architecture

The DHF performs four major functions in support of the Landsat 7 mission:

1. Landsat 7 ETM+ raw data capture and short term storage
2. Level 0R processing
3. Calibration and quality assessment of the Level 0R data
4. Landsat 7 telemetry, tracking and commanding RF interface

The DHF elements that perform these functions are the:

a. Landsat 7 Ground Station (LGS)
b. Landsat 7 Processing System (LPS)
c. Landsat 7 Image Assessment System (IAS)
d. Data Handling Facility Management Office

Figure 2-3 shows a high level view of the DHF reference architecture including these elements and their external interfaces.

2.5 DHF Element Description

2.5.1 Landsat 7 Ground Station

The Landsat 7 Ground Station (LGS) provides the services and functionality required to receive up to three simultaneous ETM+ wideband (X-band) downlinks from the Landsat 7 satellite. Specifically, the LGS provides the services to:

a. Acquire and track the Landsat 7 X-band downlink(s).

b. Downconvert the X-band signals to frequencies suitable to baseband processing.

c. Demodulate the QPSK modulated downlink to recover Format 1 and Format 2 baseband data from the downlink.

d. Recover a synchronous clock from the Format 1 baseband data and recover a synchronous clock from the Format 2 baseband data (bit synchronization).

e. Distribute Format 1 data and clock and Format 2 data and clock to the LPS for each X-band downlink received by the LGS.

The LGS produces contact schedule reports and equipment status reports that are used by the operations staff to monitor the health and performance of the Landsat 7 downlink and the LGS.

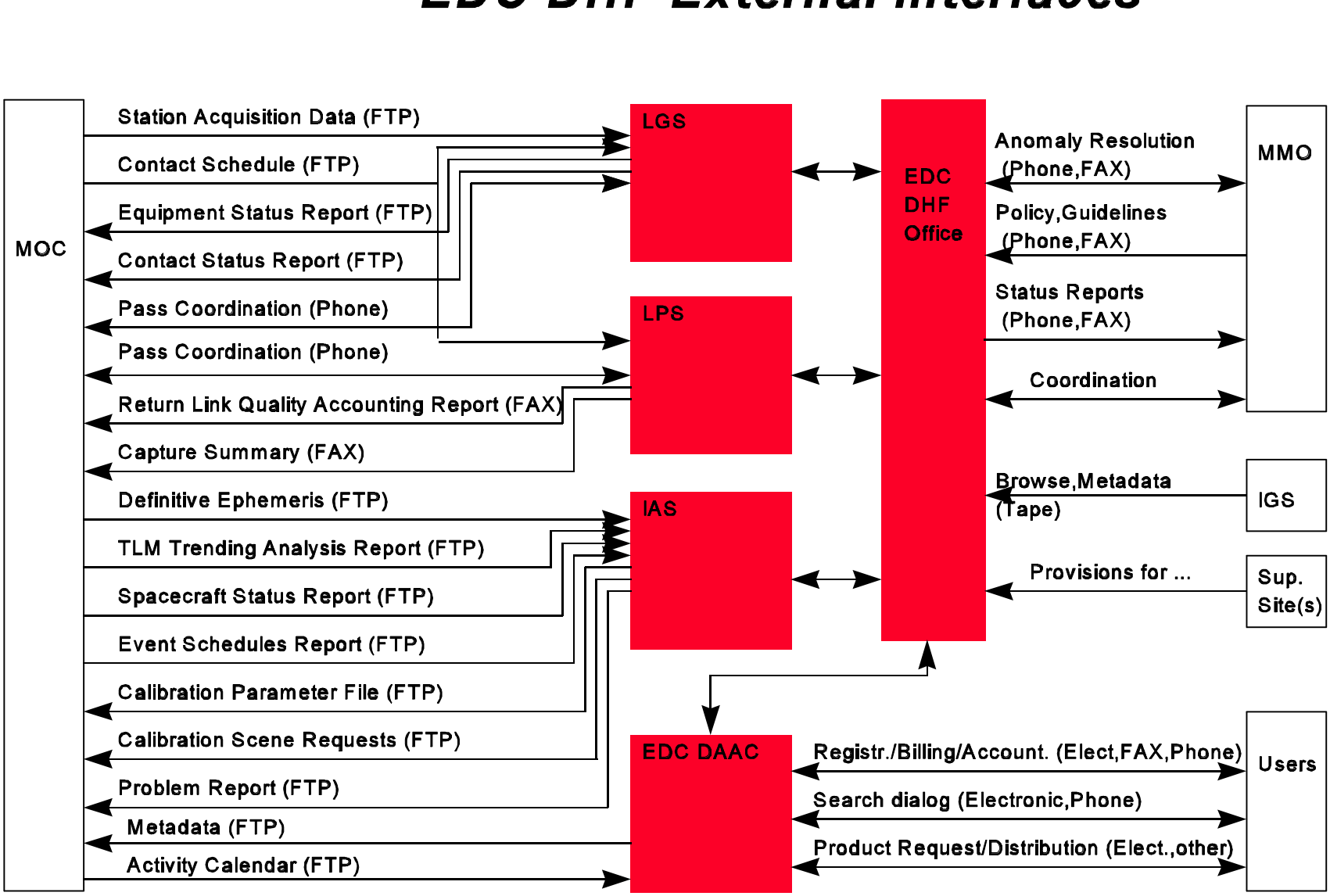


Figure 2-3. DHF Reference Architecture and External Interfaces

The LGS consists of a 10-meter X-band antenna with associated tracking and low noise amplification equipment, a RF and Telemetry subsystem (down converters, demodulators, bit synchronizers), a matrix switch, a timing subsystem and a management and control subsystem (MCS).

Refer to Landsat 7 Ground Station (LGS) Operations Concept (Document 531-OCD-GS/Landsat 7) for details on LGS functionality, implementation and operations.

2.5.2 Landsat 7 Processing System

The Landsat 7 Processing System (LPS) provides the services and functionality required to produce ETM+ Level 0R products from the unprocessed ETM+ data received by the LGS. Specifically, the LPS provides the services to:

a. Receive unprocessed ETM+ data in real time from the LGS during a Landsat 7 contact period and write the data to temporary disk storage for off-line processing.

b. Copy the unprocessed ETM+ data in temporary disk storage to the 30-day tape archive.

c. Produce sub-interval based Level 0R image data files and associated data files from the unprocessed ETM+ contact data stored on temporary disk storage.

d. Produce scene based browse image data files from the unprocessed ETM+ contact data stored on temporary disk storage.

e. Produce sub-interval based metadata files from the unprocessed ETM+ contact data stored on temporary disk storage.

f. Produce moving window displays that display a subsampled version of the Level 0R images being produced.

g. Notify the EDC DAAC of LPS data availability and support the transfer of the LPS files to the EDC DAAC for archive and distribution.

The LPS produces return link quality and accounting information (part of the metadata), transfer summary reports, capture summary reports and other production reports that can be used by the operations staff to monitor the health and performance of the Landsat 7 Ground System in general and the LPS in particular.

The LPS consists of five identical Level 0R processing strings (four on-line, one spare), two moving window display workstations, two operator interface X-terminals and one control console workstation.

Refer to Landsat 7 Processing System (LPS) Operations Concept (Document 560-3OCD/0194) for details on LPS functionality, implementation and operations.

2.5.3 Landsat 7 Image Assessment System

The Landsat 7 Image Assessment System (IAS) provides the services and functionality to perform ETM+ instrument calibration, to assess the quality of Level 0R data products (small sample) and to evaluate and monitor image related system performance. Specifically, the LPS provides the services to:

a. Request and ingest Level 0R data products from the EDC DAAC.

b. Perform radiometric calibration.

c. Perform geometric calibration.

d. Provide processing parameters to the LPS and EDC DAAC based on radiometric and geometric calibrations

e. Assess level 0R data products relative to the creation of high quality Level-1 digital image data

f. Evaluate ETM+ and system performance as it impacts image data quality.

The IAS produces a number of reports regarding the activities of the IAS. Specifically, the IAS produces:

a. Daily reports on image data quality assessment.

b. Weekly reports on satellite ephemeris accuracy.

c. Quarterly reports on radiometric and geometric performance.

d. Problem reports for anomalous events.

These reports are used by the operations and management staff to monitor the health and performance of the Landsat 7 ETM+ instrument and the Landsat 7 Ground System.

The IAS consists of anl IAS processing system and associated peripherals, a development system, an integration and test system, two analyst workstations, one IAS management workstation, one operations console and a color postscript printer.

Refer to Landsat 7 Image Assessment System (IAS) Operations Concept (December 1994) for details on IAS functionality, implementation and operations.

2.5.4 EDC Data Handling Facility Management Office

The EDC Data Handling Facility Management Office provides the services and functionality required to manage the day to day activities of the DHF and to coordinate DHF activities with the remainder of the Landsat 7 program. Specifically, the DHF Management Office (DMO) provides the following services to manage the daily operations of the DHF:

a. Provide staffing for the DHF operations, analysis, maintenance and sustaining engineering activities.

b. Train DHF operations and maintenance staff.

c. Provide DHF configuration management.

d. Provide Landsat 7 ETM+ data quality assurance.

e. Development and maintenance of DHF operational procedures.

f. Management of DHF sustaining engineering activities.

g. Facility management

h. Anomaly resolution

i. Resource scheduling.

j. Coordination with commercial vendors for maintenance support.

The DMO provides the following services to coordinate DHF activities with the rest of the Landsat 7 project:

a. Landsat 7 Mission Management Office coordination

b. Landsat 7 Mission Operations Center coordination

c. CoordinateEDC DAAC Management Coordination.

d. Coordinate the ingest of IGS browse and metadata with the EDC DAAC.

e. Coordinate receipt of supplemental Landsat 7 X-band data.

f. Anomaly resolution.

The DMO collects production status reports, equipment status reports and problem reports from all DHF elements and support activities. These reports are used by DMO staff to assess the health and performance of the DHF.

The DMO consists of a manager responsible for the DMO operations. The DMO manager will draw personnel services from existing EDC line organizations as required to provide support to the Landsat 7 mission.

Refer to EDC Data Handling Facility Operations Support Plan (DHF-OPS-002D) for details of DMO functionality, implementation and operations.

2.6 DHF External Interfaces

The DHF interacts with a number of systems, facilities, networks and organizations to accomplish the Landsat 7 mission. These interfaces are represented in a high-level context diagram earlier in Figure 2-3. This section describes the major data flows between the DHF and external elements. The external elements for this discussion are the:

a. Landsat 7 Satellite.
b. Landsat 7 Mission Operations Center (MOC).
c. Landsat 7 Mission Management Office (MMO).
d. EDC DAAC.
e. Alaska Ground Station (AGS)
f. Spitzbergen Ground Station (SGS)

Figure 2-3 identifies major data flows between the DHF and external elements.

Each external interface is discussed by introducing the external element and briefly describing the major data flows between the element and the DHF. References to specific inter-element interface control documents are given.

2.6.1 Landsat 7 Satellite Interface

The Landsat 7 satellite uses the on-board wideband solid state recorder to capture real-time imaging data from the 150 Mb/sec channels, when this data cannot be transmitted to the ground in real-time. The recorder can hold up to 42 minutes of imaging data. The Landsat 7 spacecraft uses two of its three 150 Mb/sec X-band direct downlinks to transmit real-time data and recorded image wideband data or two downlinks of recorded data to the LGS. The LGS handles each downlink identically without regard to whether it is real-time or playback data. The satellite may also downlink real-time and/or recorded data to the AGS or SGS for tape transfer to the LGS. The satellite is also capable of downlinking real-time data to up to three IGSs simultaneously.

The X-band downlink service to the LGS will be available during intervals when a Landsat 7 satellite-to-LGS line-of-sight exists and the LGS local elevation angle is greater than or equal to 5 degrees and clear of local masking. The X-band downlink service below 5 degrees is on a Best Level-of-Effort (LOE) basis. Wideband science data is downlinked to the LGS through the use of Gimbaled X-band Antennas (GXA), as scheduled by the MOC, operating at frequencies of 8082.5, 8212.5 and 8342.5 MHZ.

Transmission from the satellite to LGS of real-time science data from the ETM+ payload will be at a rate of 150 Mb/sec. Recorded ETM+ payload data will be played back by the Solid State Recorder (SSR) at a rate of 150 or 300 Mb/sec and transmitted over one or two 150.0 Mb/sec links. Up to three separate 150 Mb/sec downlinks are supported by the satellite to provide a combination of real time and recorded science data. Each 150 Mb/sec link consists of two 75.0 Mb/sec data streams which are modulated on the In-phase (I) and Quadrature-phase (Q) channels. The LGS will process only two of the 150 Mb/sec streams simultaneously, however, the satellite does not preclude processing all three downlinks simultaneously.

Refer to Radio Frequency Interface Control document Between Landsat 7 and the Space Network (SN), Ground Network (GN) and Landsat 7 Ground Station (LGS) (Document

Number 23007638) for further interface details.

2.6.2 Mission Operations Center Interface

The Landsat 7 MOC, located in Building 32 at Goddard Space Flight Center (GSFC) provides the hardware and software systems necessary for the successful execution of real-time and off-line Landsat 7 satellite flight operations activities. The flight operation team at the MOC ensures that spacecraft conditions are monitored and controlled. Along with ensuring the health and safety of the spacecraft, the flight operation team schedules and executes science data capture. All command and control functions of the spacecraft will take place from the MOC. The MOC will facilitate resource scheduling and interface with the appropriate elements required to conduct mission operations.

The MOC has operational interfaces with the LGS, LPS and IAS. It also has a status/coordination interface with the EDC DMO.

The MOC/LGS interface products consist of:

a. Station Acquisition Data (MOC to LGS).
b. Contact Schedule (MOC to LGS).
c. Contact Status Report (LGS to MOC).
d. Equipment Status Report (LGS to MOC).
e. Pass Coordination (2-way interchange between the MOC and the LGS).

This interface is shown in Figure 2-3. Refer to Interface Control Document (ICD) Between the Landsat 7 Mission Operations Center (MOC) and the Landsat 7 Ground Station (LGS) for further interface details.

The MOC/LPS interface products consist of:

a. Contact Schedule (MOC to LPS).
b. Return Link Quality and Accounting Report (LPS to MOC, on exception only).
c. Capture Summary (LPS to MOC, on exception only).
d. Pass coordination (two-way interchange between the LPS and MOC during data capture).

This interface is shown in Figure 2-3. Refer to Memorandum of Understanding Between the Landsat 7 Processing System (LPS) and The Landsat 7 Mission Operations Center (MOC) for further interface details.

The MOC/IAS interface products consist of:

a. Definitive Ephemeris (MOC to IAS).
b. Telemetry Trending Analysis Report (MOC to IAS).
c. Spacecraft Status Report (MOC to IAS).
d. Event Schedules Report (MOC to IAS).
e. Calibration Parameter File (IAS to MOC).
f. Calibration Scene Requests (IAS to MOC).

g. Problem Reports (IAS to MOC).

This interface is shown in Figure 2-3. Refer to Landsat 7 Mission Operations Center (MOC) to Landsat 7 Image Assessment System (IAS) Interface Control Document (ICD) for further interface details.

The MOC/EDC DMO interface is not a formally defined interface. It consists of general status information and anomaly resolution coordination.

2.6.3 Mission Management Office Interface

The DHF/MMO interface is illustrated in Figure 2-3. The DHF interface with the MMO is implemented by the DMO. This interface is the only formal conduit for Landsat 7 project direction to be disseminated to the DHF and for DHF status to be disseminated to the MMO. The interface is via phone, FAX and E-mail.

2.6.4 EDC DAAC Interface

The DHF/DAAC interface is illustrated in Figure 2-4. Level 0R files are sent to the DAAC for archival. Coordination messages are sent to ensure proper transfer. These Level 0R products may be retrieved by IAS for calibration purposes. IAS also sends a Calibration Parameter file to the DAAC when it is updated. The interface from LPS to the DAAC is implemented via the EBnet router. The interface with IAS is implemented via the EDC Campus LAN. Both of these interfaces transfer large amounts of image data (~5 GB/day to IAS and 125 GB/day from LPS).

In addition, customer support issues and trouble tickets are sent from the DAAC to the DMO on an “as-needed” basis.

2.6.5 Remote Ground Station Interfaces

The DHF will also receive Landsat 7 data from two remote ground stations on a routine basis. Data will be regularly received at NASAs receiving station near Poker Flats, Alaska and also at a joint NASA and Norwegian ground station on the island of Spitsbergen in the Svalbard archipelago north of Norway.

The course of events for the receipt and transfer of data from both of these stations is as follows. Each station will record data from any scheduled passes and record the raw data to tape, one tape for each of Format 1 and Format 2 per downlink channel. Information about each pass recorded will be transmitted via file FTP to the Wallops Support Group who manage these remote stations. EDC will get courtesy copies of these Downlink Report (DNL) files. Every two days the tapes will be removed from their recorders and new ones installed. Back-up copies of the tapes containing data will be made before sending those two days of tapes to EDC via commercial carrier. When the tapes are sent an additional file called the Tape Shipment Report File (TSR) will be sent via FTP to WSG and EDC notifying them of the tape shipment and the tapes included within.

When the package containing the tapes is received at EDC the contents will be matched against the TSR to ensure that all of the tapes were received. EDC will update the Tape Transfer Database to

reflect the presence of the tapes and schedule their ingest as appropriate. The tapes are then ingested at the LGS just as if they had been recorded here.

Once final processing has been successfully accomplished a Tape Acknowledgment Report (TAR) is sent out via FTP by EDC notifying WSG and the remote stations that the data was successfully ingested and that there is no need to maintain the backup copies of the tapes that were made and have been retained at the remote locations. Should any problems occur reading any portion of the data on any tape EDC would generate an internal problem report and also report the problem to WSG and the remote stations via the TAR report so that backup copies of the tape can be sent to EDC to replace the lost data interval.

2.7 DHF Internal Interfaces

Interfaces among the DHF elements are shown in Figure 2-4. Interface details can be found in the interface control documents listed in Section 1.5.

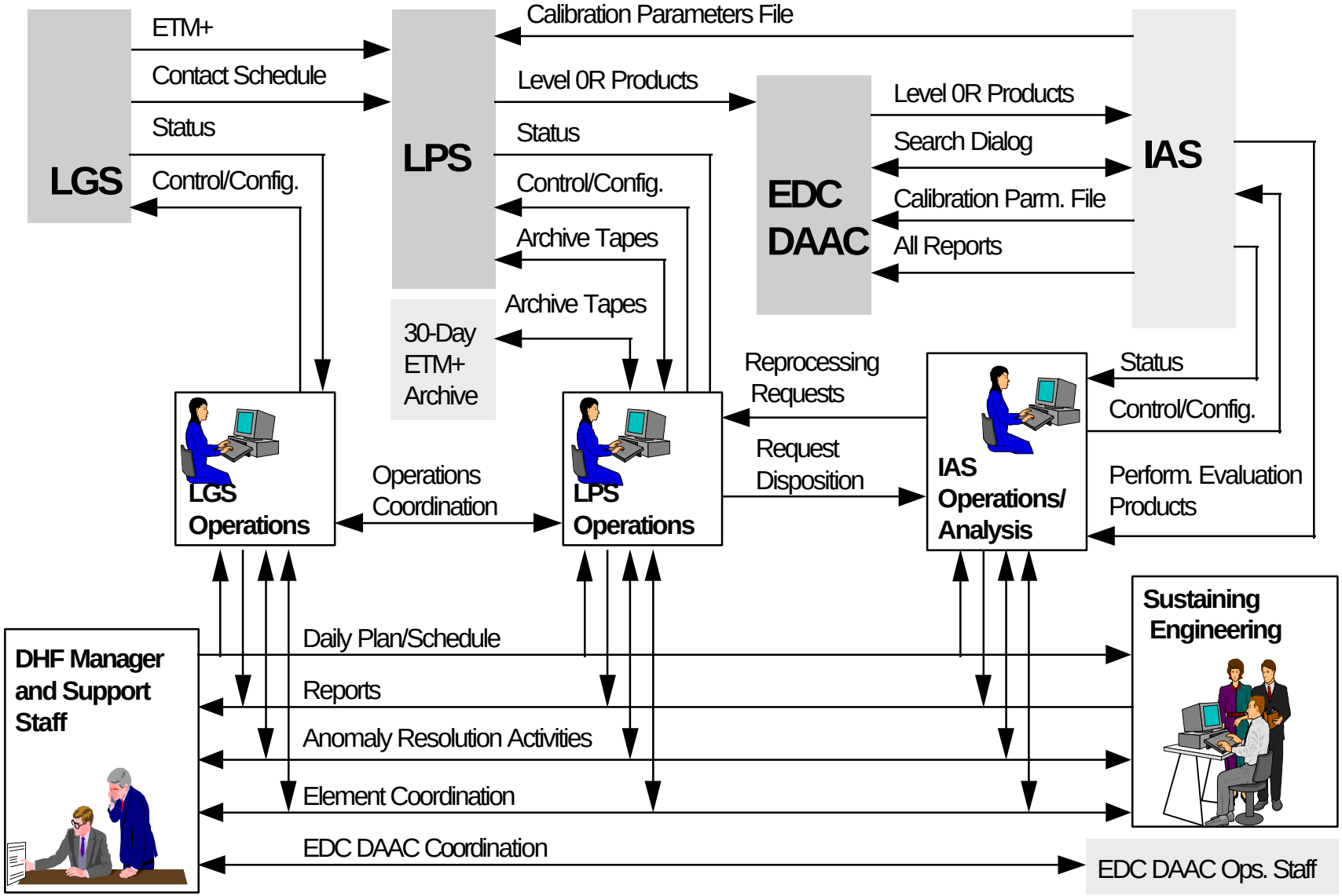


Figure 2-4. DHF Internal Interfaces

Section 3. DHF Operations

3.1 Nominal Operations

A typical 24 hour operational time line for the DHF is shown in Figure 3-1. This time line indicates that LGS, LPS, and IAS operations supporting wideband data capture and level 0R processing continue 24 hours a day, seven days a week. EDC DAAC operation supporting data archive and distribution is a 24 hour a day, seven day a week effort. Image analysis is performed nominally on an eight hour a day, Monday through Friday schedule. Sustaining engineering activities consisting of hardware and software maintenance and training are nominally an eight hour a day, Monday through Friday effort. On-call maintenance support will be available 24 hours a day, seven days a week.

A Day in the Life of Landsat 7 at EDC

This narrative is meant to represent a nominal day in the life of Landsat 7 at the DHF. Times are not the same every day, due to the 16 day cycle in satellite coverage. Tapes from Alaska (AGS) and Spitzbergen (SGS) may not arrive every day. Calibrations may not take place every day. There may be as many as 25 reprocessing requests from IAS or there may be none.

Day shift Arrival

Normal dayshift begins at EDC at 7:30 a.m. Local time. As the new Ops crew arrives, each crew member must review the daily schedule and problem reports for their area. The LGS and LPS crews review the contact schedule for the day. The LGS crew reviews the Orbital Elements to ensure they are up to date. Any processing that is underway would be discussed and then any upcoming events for the day. Shift change occurs when the night shift operators log out and the day shift logs in.

For the first pass of each session, the LPS operator will check disk space for the System, Capture and Output disks. The LPS operator confirms deletion of output files from the previous days' activities. The LPS operator will mount blank tapes if needed and verify the correct tapes are mounted. Any tapes that are removed would be labeled with computer-generated labels containing contact date and time, X-band downlink antenna number and I or Q channel designator and the LPS string that captured the data. If a pre-pass loop-back or other test is required, it will be started now. Also, although the Level 0R parameters are not expected to be adjusted very often, the short period between shift change and the first pass is one opportunity to do this.

Although reprocessing requests could arrive from IAS at virtually any time during the day, few, if any, should arrive during this session.

Preparation for the first pass of the day

The dayshift begins preparation for the first pass of the day at around 9:00 a.m. This time will change depending on the first pass start time. At this time, the LGS and LPS operators will confirm the contact time with each other and possibly with the Project pass schedule. Both the LPS and LGS operators will verify their voice connections to the MOC. They would also normally discuss the system configuration, i.e., the LGS presets (which LPS string will be connected to which LGS channel) for this pass. This will probably be more of a confirmation than an action which requires

discussion since certain strings will normally be tied to certain channels. Any system problems will also be discussed at this time.

If the LGS configuration is not the commanded one, the LGS operator will make the appropriate changes at this time. Then he will verify that the LGS is configured properly. Normally, the Monitor and Control System (MCS) and Ground System Control (GSC) would already be up so no additional action would be required. However, in addition to checking the main MCS display the operator might check one or two tell-tales (such as the presets setting or the tracking command processor) to ensure that everything is set up properly. The operator will also verify that the antenna is at the correct azimuth, elevation and tilt for the stowed position.

Meanwhile the LPS operator begins his preparation by coordinating the contact with the LGS operator and the Project pass schedule. Then he will verify the LPS String configuration or reconfigure it if necessary. He will also check to ensure that the automatic scheduled data capture process is ready for the pass.

First pass of the day

Shortly before the pass the antenna will move to the designated acquisition position. The LGS operator will monitor this movement confirming the position at which the antenna stops. He would also notice slow movement caused by inclement weather or mechanical difficulties. One minute before acquisition, the MACS autocapture system will spawn RDCS. Shortly after that the LPS operator will verify that the data capture process is ready. At acquisition several things happen at once. As the signal strength rises above the preset value, the antenna begins auto-tracking. The synchronizer shows a “Locked” indication and data begins to flow to the LPS. At the LPS, indicators show data being captured to disk.

Post-pass activities

After the pass the antenna will move to the designated stow position. The LGS operator will monitor this movement confirming the final position of the antenna. If there are any anomalies, a post-pass analysis would be sent to the MOC.

Preparations for the second pass of the day and subsequent

Preparations for the second pass are almost identical to the first. Communications will be brought up between operators and the MOC. If the system has been reconfigured for any reason it will be returned to operational status. If the configuration is not the one required for this pass the LGS operator will change to the appropriate one at this time. Normally, MCS and GSC would already be up so no additional action would be required. Meanwhile the LPS operator verifies the LPS String configuration or reconfigures it if necessary. He will also verify that the automatic scheduled data capture process is ready for the pass.

At approximately 10:00 a.m. tapes will be arriving via courier from AGS and SGS. The Operator logs their arrival and schedules time for loading. These tapes may have to be acclimated, depending on outside temperatures, for up to 8 hours before use.

The Contact Schedule and Orbital Elements for the next day will have been transmitted by the MOC at approximately 1030 Local time (1630Z). If a pass is in progress, no action will be taken until the

end of the pass. Then they will be ingested by the LPS and propagated to all operational strings. LGS.

Second pass of the day

The second pass is identical to the first. Shortly before the pass the antenna will move to the designated acquisition position. The LGS operator will monitor this movement confirming the position at which the antenna stops. Fifteen seconds before the AOS the LPS operator will re-verify that the automatic scheduled data capture process is ready.

Post-pass activities

After the pass the antenna will move to the designated stow position. The LGS operator will monitor this movement confirming the final position of the antenna. If there are any anomalies, a post-pass analysis would be sent to the MOC.

Third pass of the day

At times during the 16 day Landsat 7 cycle only two passes will happen in one session or the other due to orbital constraints. If this day occasions three passes, the activities of the third pass are identical to the second.

Swing Shift Arrival

Normal swing-shift at EDC begins at 4:00 p.m. As the swing crew arrives, each crew member must review the daily schedule and problem reports for their area. The LGS and LPS crews review the contact schedule for the day. The LGS crew reviews the Orbital Elements to ensure they are up to date. The LPS operator confirms deletion of output files from the mornings activities.

Sometime before the first pass of the second session, the LPS operator must check disk space for the System, Capture and Output disks. He will mount blank tapes if needed and verify that the correct tapes are mounted.

It will normally be nearly 4 hours before the first pass, so the first half of the swing shift will be used for AGS and SGS processing activities, reprocessing activities, etc....

The Daily Schedule for the next day will have been produced by the DHF Management Office. This would normally be distributed by 4:00 p.m. so the dayshift can review it before leaving for the day.

Preparation for the first pass of the second session

Preparation begins for the first pass of the second session at around 7:45 p.m. This time will change depending on the time in the 16 day cycle. There are few differences between the actions at this time. At this time, the LGS and LPS operators will confirm the contact time with each other and possibly with the Project pass schedule. Both the LPS and LGS operators will verify their voice connections to the MOC. They would also normally discuss the system configuration, i.e., the LGS presets (which LPS string will be connected to which LGS channel) for this pass. Many of these actions will probably be simply confirmation of status, although if tapes have been played or tests

run, the configuration may have changed slightly since the last session. Any system problems might also be discussed at this time.

However, if the configuration is not the expected one the LGS operator will change to the commanded one at this time. Then he will verify that the LGS is configured properly. Normally, MCS and GSC would already be up so no additional action would be required. However, in addition to checking the main MCS display the operator might check one or two tell-tales (such as the presets setting or the tracking command processor) to ensure the everything is set up properly. Another check might be to verify that the antenna is showing the correct azimuth, elevation and tilt for the stowed position.

Meanwhile the LPS operator begins his preparation by coordinating the contact with the LGS operator and the Project pass schedule. Then he will verify the LPS String configuration or reconfigure it if necessary and that the Raw Data Capture Software (RDCS) is running. He will also verify that the automatic scheduled data capture process is ready for the pass.

First pass of the second session.

Shortly before the pass the antenna will move to the designated acquisition position. The LGS operator will monitor this movement confirming the position the antenna stops at. He would also notice slow movement caused by inclement weather or mechanical difficulties. Fifteen seconds before the AOS the LPS operator will re-verify that the automatic scheduled data capture process is ready. At acquisition several things happen at once. As the signal strength rises above the preset value, the antenna begins auto-tracking. The Synchronizer shows a Locked indication and data begins to flow to the LPS. At the LPS, indicators show data being captured to disk.

Post-pass activities

After the pass the antenna will move to the designated stow position. The LGS operator will monitor this movement confirming the final position of the antenna. If there are any anomalies, a post-pass analysis would be sent to the MOC.

Preparations for the second pass of the second session.

Preparations for the second pass are almost identical to the first. Communications will be brought up between operators and the MOC. If the system has been reconfigured for any reason it will be returned to operational status. If the configuration is not the one required for this pass the LGS operator will change to the appropriate one at this time. Normally, MCS and GSC would already be up so no additional action would be required. Meanwhile the LPS operator verifies the LPS String configuration or reconfigures it if necessary. He will also verify that the automatic scheduled data capture process is ready for the pass.

Second pass of the second session.

The second pass is identical to the first.

Post-pass activities

After the pass the antenna will move to the designated stow position. The LGS operator will

monitor this movement confirming the final position of the antenna. If there are any anomalies, a post-pass analysis would be sent to the MOC.

Grave Shift Arrival

Mid-shift will normally arrive shortly before the third pass if one occurs. At least once during the 16 day cycle, the shift change will occur during a pass. When this occurs the shift change will take a little longer.

Third pass of the second session.

At times during the 16 day Landsat 7 cycle only two passes will happen in one session or the other due to orbital constraints. If this day occasions three passes, the activities of the third pass are identical to the second.

Post-pass activities

After the pass the antenna will move to the designated stow position. The LGS operator will monitor this movement confirming the final position of the antenna. If there are any anomalies, a post-pass analysis would be sent to the MOC.

After the third pass, the mid-shift is routine. LPS processing must be completed for the second session. Any reprocessing requests may be handled and tapes from Alaska and Spitzbergen may be processed.

Nominal operations have been divided into two categories:

1. Principal Activities
2. Support Activities

Principal activities are defined by the following operational scenarios:

1. Wideband Data Capture
2. Level 0R Processing
3. Image Assessment
4. Level 0R Data Archive and Distribution
5. DHF Operational Readiness Testing

Operational procedures will be produced for each of these scenarios. Operational procedures will be documented in a separate EDC Landsat 7 DHF Standard Operating Procedures (SOPs) document. The remainder of this section describes these operational scenarios at a summary level.

Support activities are defined by the following operational scenarios:

1. Configuration Management

2. Quality Assurance
3. Operations Scheduling
4. System Maintenance
5. Training
6. Anomaly Resolution
7. Security
8. Sustaining Engineering

These areas are covered in more detail in the Landsat 7 DHF Operations Support Plan.

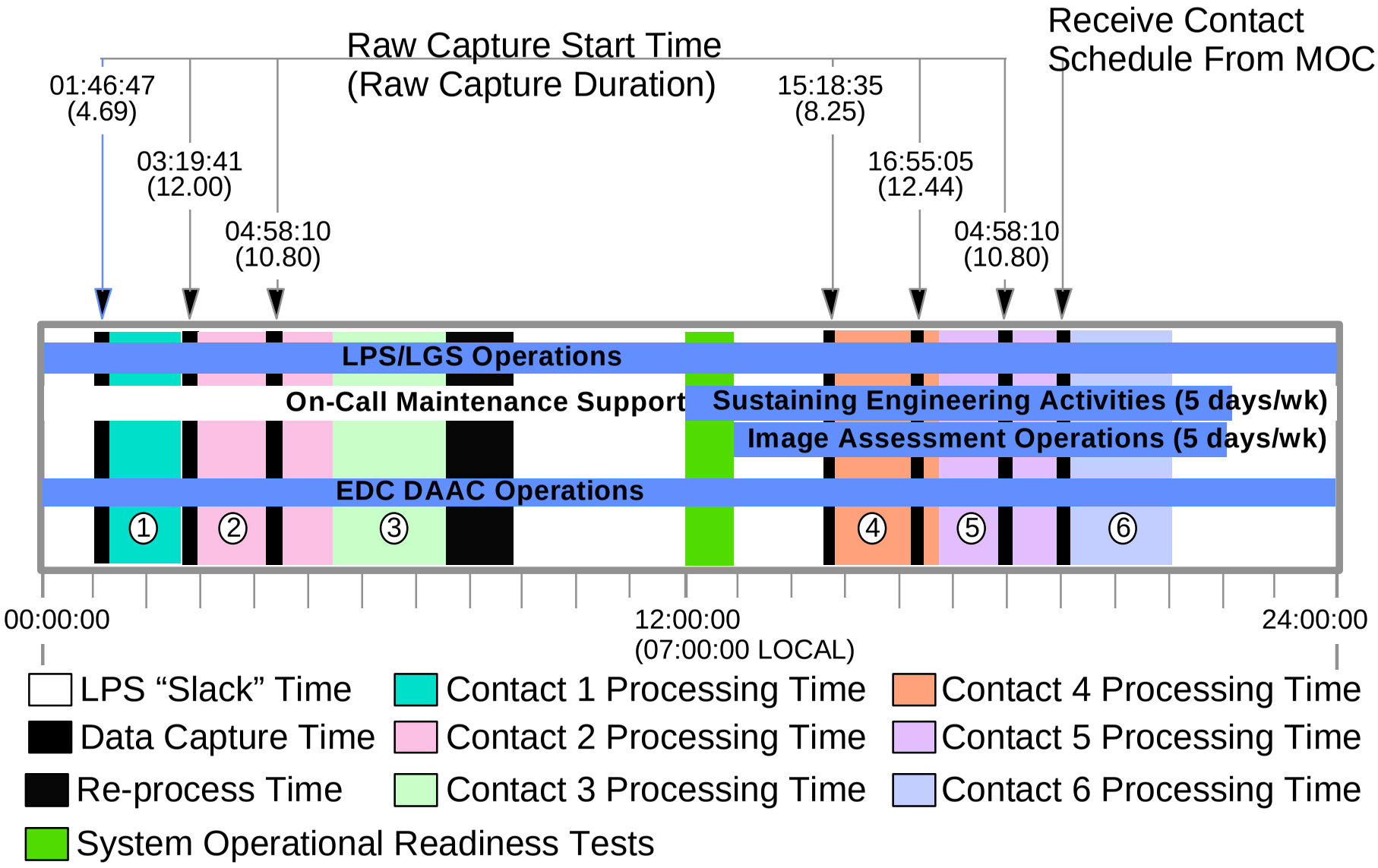


Figure 3-1. EDC DHF Operational Timeline

3.1.1 Wideband Data Capture

Landsat 7 Wideband data capture capability at the DHF is performed by the Landsat 7 Ground Station (LGS) and the Landsat 7 Processing System (LPS). Landsat 7 X-band data is received directly from the Landsat 7 satellite, through a 10 meter antenna at the LGS, through the radio frequency and telemetry equipment and finally written to RAID on the LPS for later processing to Level 0R.

The Landsat 7 orbit geometry allows for a maximum of six LGS contacts per day, with an average of about 5.4 per day and each averaging about 10 minutes in length.

LGS contains a total of three logically independent processing strings. During normal operations, the LGS will receive two downlink frequencies simultaneously. Two strings will be used to support normal operations, while the third string is the backup, test, development and training string.

About 15 minutes prior to contact period acquisition time, the LGS Operator will ensure proper configuration to receive the raw wideband data. LPS Operator will also ensure proper configuration of the LPS at this time. At start of contact period time, the LGS Operator will note presence of X-band carrier and tracking equipment will go into autotrack mode.

The LGS operator and the LPS operator will each monitor their equipment for proper status. Both operators will be in voice contact with the MOC during this period. If any anomalous conditions are noted, they will be relayed to the MOC via voice link immediately. Also, after an anomalous condition the LGS Operator will FTP a post-pass summary report that includes limited status information (such as signal strength and equipment lock status) to the MOC.

3.1.2 Level 0R Processing

Level 0R processing is performed by the LPS and controlled and monitored by the LPS Operator. The LPS reads the raw ETM+ data that was recorded as part of the wideband data capture scenario and produces Level 0R files (image band files, PCD files, MSCD files, calibration files, metadata files and browse image files) for archive in the EDC DAAC. Concurrently, the LPS writes the raw ETM+ data to the 30-day archive. The LPS notifies the EDC DAAC that the level 0R files are available for archive. The EDC DAAC retrieves the files in accordance with its processing schedule. The LPS supports this transfer and reports on its status.

After a contact period with the spacecraft, the LPS automatically begins the Level 0R processing of the newly captured raw wideband data. This will process the raw wideband data to Level 0R in HDF on the LPS output RAID for the EDC DAAC to retrieve. The raw wideband data is also automatically written to 30 day archive tapes on DLT, concurrent with Level 0R processing, so it is available for reprocessing if necessary. Both the Level 0R processing and the write of the raw wideband data to the 30 day archive tapes are started automatically, based on the contact schedule and successful acquisition. Figure 3.1.2-1 shows the Level 0R Processing Context Diagram and Figure 3.1.2-2 shows the Level 0R Processing Flow Diagram.

During normal operation, four of the five LPS strings will be in production mode and the fifth string will be a spare to be used as backup. The LPS strings generate Level 0R data, browse and

metadata files and make the files available for transfer to the EDC DAAC. Level 0R processing and write to 30 day archive tape will be suspended during wideband data capture.

Processing must be completed within 16 hours of the arrival at the LPS of the raw wideband data. LPS may receive the equivalent of 250 ETM+ scenes per day of raw wideband data. The LPS processes data on a contact period basis, but generates the LPS files on a sub-interval basis, creating scene specific metadata entries, for later transfer to the EDC DAAC.

The LPS operator is responsible for operating and monitoring all four strings from the Operational Console. The operator will manage the 30 day archive, ensuring blank tapes are loaded, when necessary, and full tapes are unloaded, labeled and stored properly. The operator will also monitor the moving window display, watching for gross error conditions such as severe dropped lines or unrecognizable image data. The operator will also monitor system messages showing successful acquisition, Level 0R start and completion, write to 30 day archive start and completion and ensure proper transfer of LPS files from LPS to EDC DAAC.

The operator also generates reports on each string as required. Under anomalous situations a LPS Quality/Accounting Report will be sent to the MOC and the DHF QA Engineer. In addition, production statistics reports will be generated for the DMO from reports such as LPS Quality/Accounting Report, Files Transfer Summary, Journal/Log Files and other long term reporting statistics.

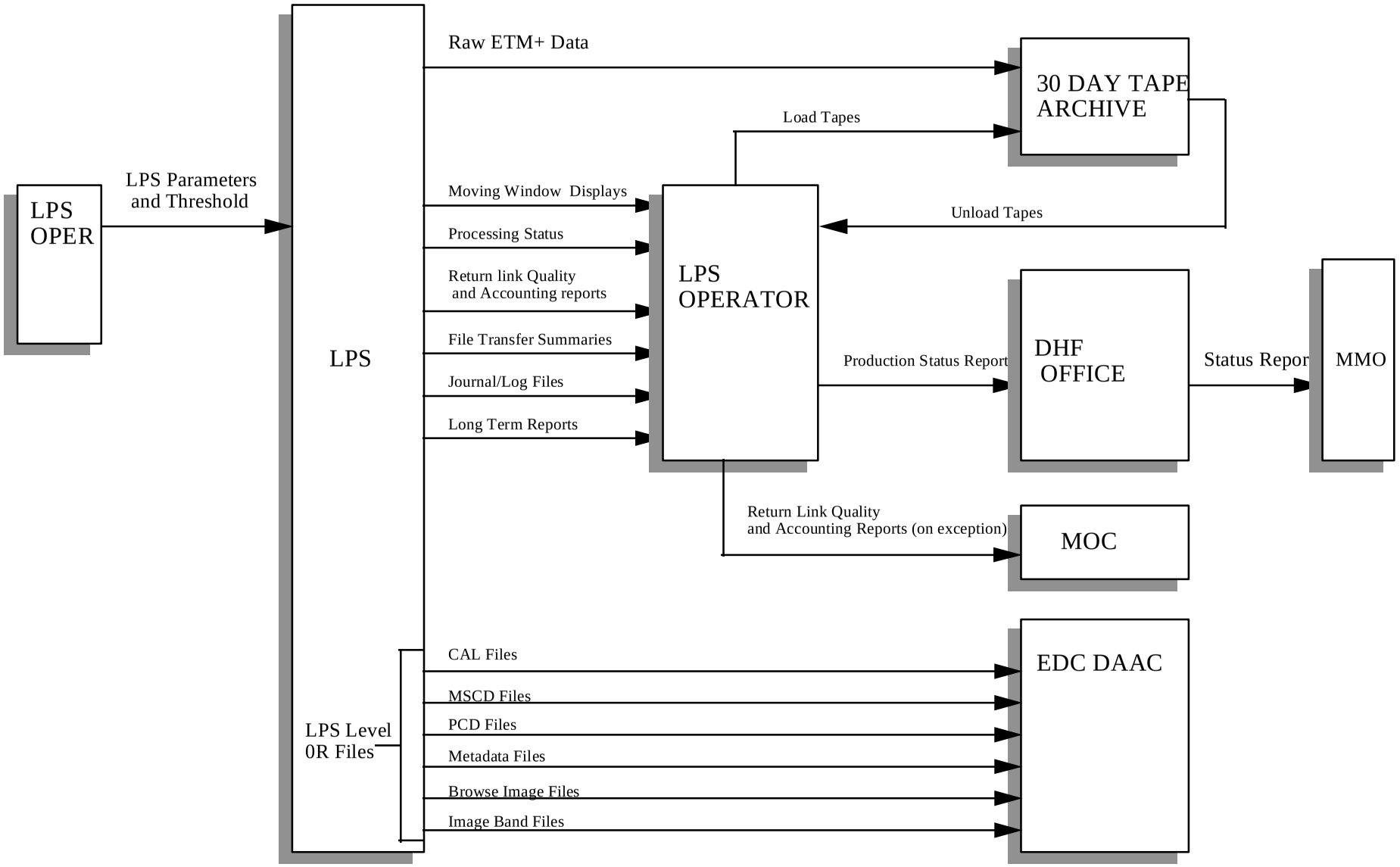


Figure 3.1.2-1. EDC DHF Level 0R Processing Context Diagram

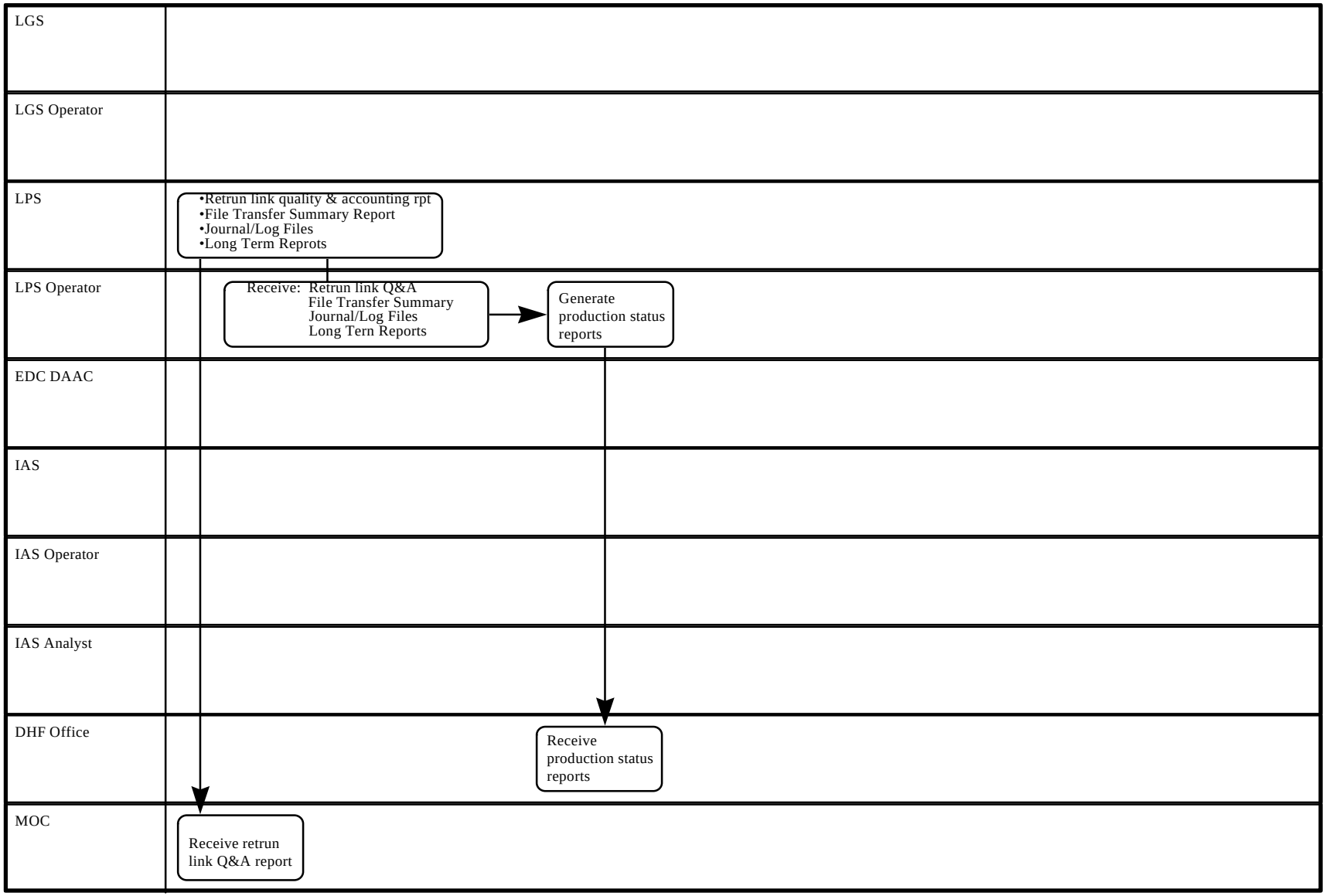


Figure 3.1.2-2. EDC DHF Level 0R Processing Process Flow Diagram

3.1.3 Image Assessment

Image Assessment and Calibration is performed by two image analysts using IAS. The IAS analyst sends image acquisition requests for various calibration images to the MOC. The MOC schedules these scenes for acquisition by the Landsat 7 ETM+ instrument. After these scenes have been acquired and ingested into the DAAC, the IAS operator requests the image data from the DAAC along with definitive ephemeris from the MOC. IAS uses this data to create/modify the Calibration Parameter file.

Refer to Figure 3.1.3-1 for an Image Assessment context diagram. Refer to Figure 3.1.3-2 for an Image Assessment process flow diagram of the Opportunistic Calibrations and Figure 3.7.3-3 for a flow diagram of the Scheduled Calibrations.

The IAS analyst determines which calibration scenes are required based on current assessment needs. An image acquisition request or requests for partial aperture solar calibrator, full aperture solar calibrator and ground look calibration images are then sent to the MOC via FTP. The MOC schedules these scenes for acquisition by the Landsat 7 ETM+ instrument. IAS is informed of the availability of the requested scenes via the Event Schedules Report from the MOC. These scenes are typically available at the DAAC 24 hours after they are scheduled to be acquired, unless outside factors (i.e., cloud cover) intervene. The IAS operator requests these scenes from the EDC DAAC after acquisition. At this time the operator would also request definitive ephemeris from the MOC.

The IAS analysts request a selected ETM+ scene from the EDC DAAC approximately 10 times per day. They then use IAS to process the data to Level 1R and 1G for assessment as Level 1 products. Image data are assessed with respect to their geometric and radiometric qualities on an individual sample and long term trending basis.

Data quality assessments, reports and improved processing instructions are sent to the EDC-DAAC, LPS, MOC and the DMO for forwarding to the MMO.

These reports are used by the operations and management staff to monitor the health and performance of the Landsat 7 ETM+ instrument and the Landsat 7 Ground System.

3.1.4 Level 0R Data Archive and Distribution

The Level 0R data archive and distribution services are provided by the EDC DAAC. The EDC DAAC is an element of the Earth Observing System Data and Information System (EOSDIS).

The DMO is responsible for coordinating with the EDC DAAC to assure that Landsat 7 mission requirements are met. The DMO receives reports on EDC DAAC operational status. The DMO provides operational status of the DHF to the EDC DAAC.

The EDC DAAC ingests Landsat 7 ETM+ Level 0R image band files, calibration files, mirror scan correction data files (MSCD), payload correction data (PCD) files, metadata files and

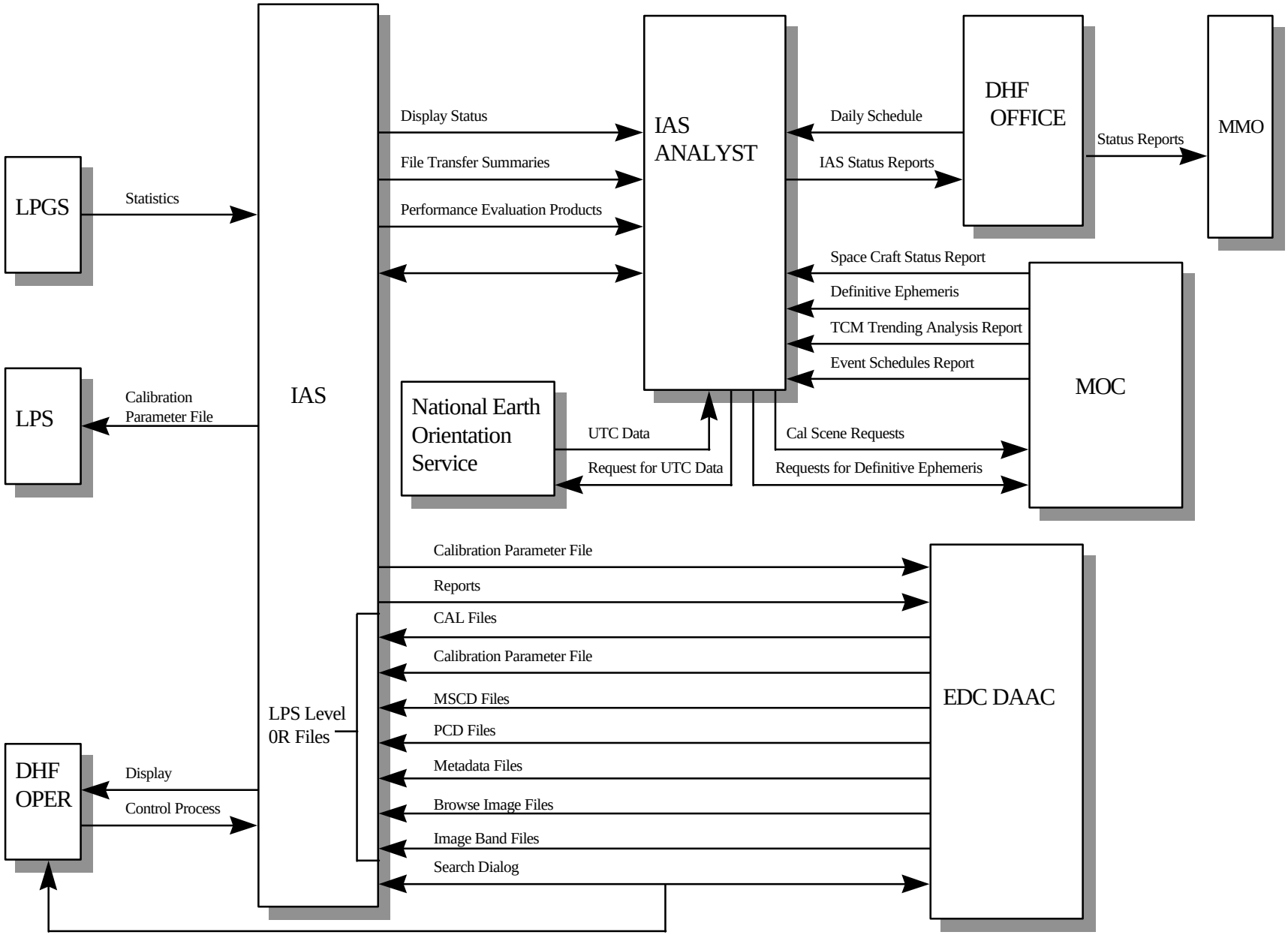


Figure 3.1.3-1. EDC DHF Image Assessment Context Diagram

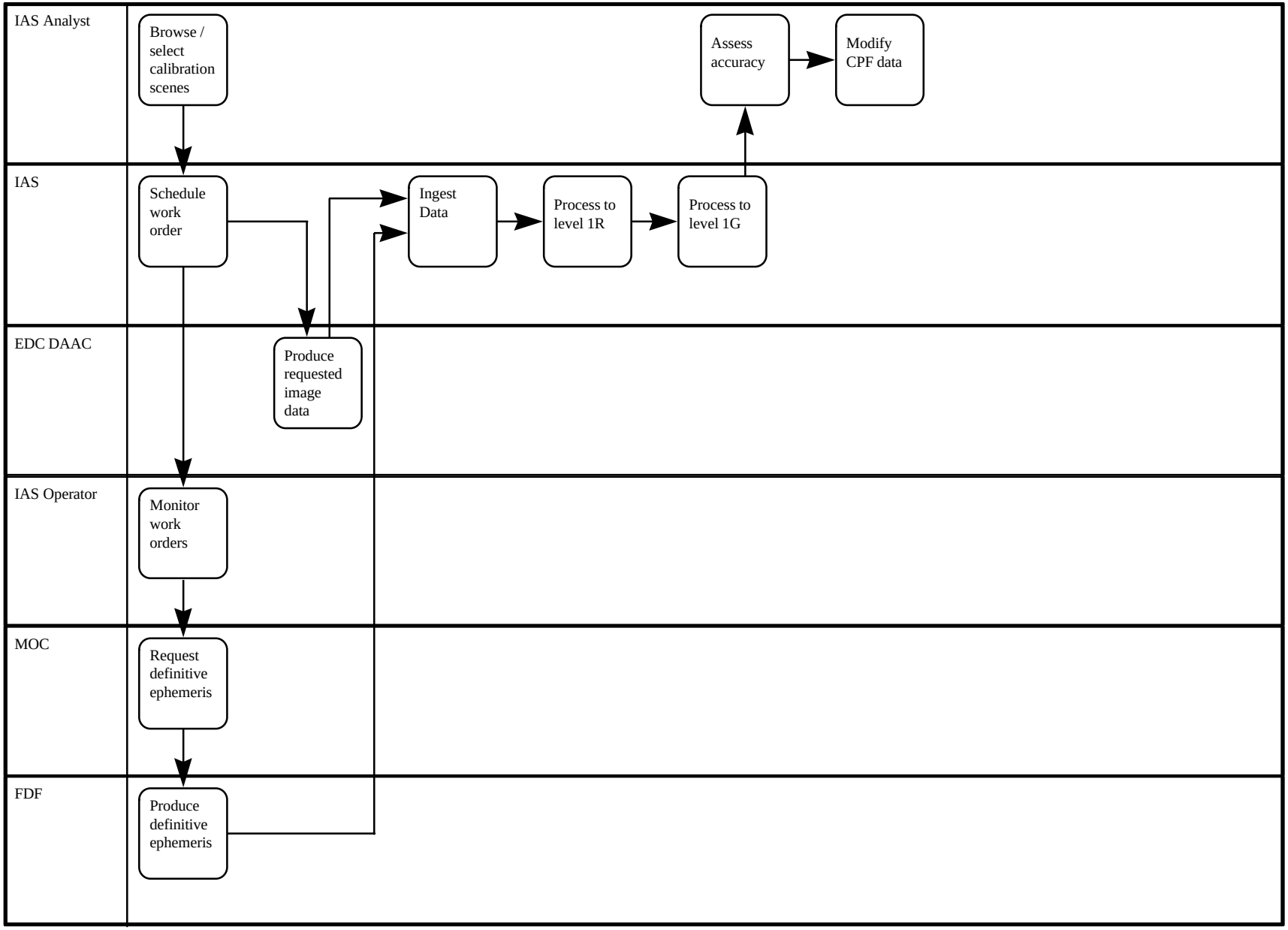


Figure 3.1.3-2. EDC DHF Image Assessment Flow Diagram for Opportunistic Calibrations

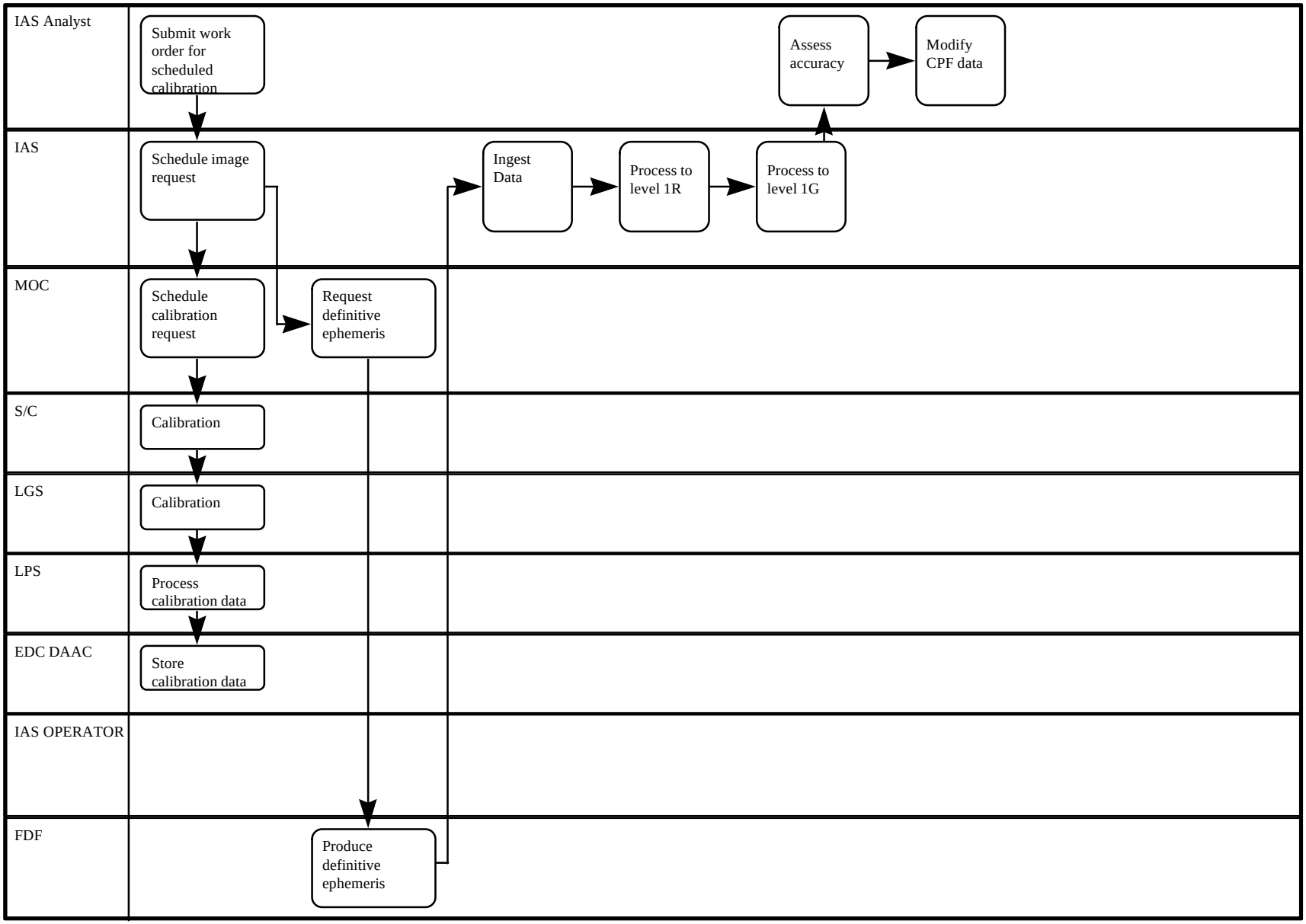


Figure 3.1.3-3. EDC DHF Image Assessment Flow Diagram for Scheduled Calibrations

browse image files from the LPS. The EDC DAAC archives the data and makes it available for query, browse and order by the Landsat 7 user community. The EDC DAAC also provides a comprehensive user services function.

3.1.5 DHF Operational Readiness Testing

DHF operations and maintenance personnel will perform daily operational readiness tests (ORT) on the DHF equipment. These tests will be scheduled and completed prior to the first morning (local time) Landsat 7 contact period. Status reports containing test results will be provided to the DMO. The DMO will track performance over time and instigate corrective action if required.

The daily ORT tests will consist of (at a minimum) bit error rate tests of the LGS and tests of the LPS raw data capture system (RAID disks). Further tests of the off-line processing functions of the DHF will be performed in accordance with the DHF maintenance plan or when performance degradation is suspected. Refer to Figure 3.1.5-1 for details of the Operational Readiness Test Context and Figure 3.1.5-2 for a flow diagram.

3.1.6 Operations Scheduling

The DMO will control access to and usage of the EDC Landsat 7 DHF system via a daily operations schedule. The purpose of the operations schedule is to schedule operations personnel and to control access to the system for training, testing, maintenance and other support activities. The goal of the scheduling process is to ensure conflict-free utilization of the DHF in order to maximize DHF availability to support the Landsat 7 mission. Refer to Figure 3.1.8-1 for a context diagram for these functions. Note that this diagram reflects an internal DMO architecture that is discussed in Section 4.

The DMO will produce the operations schedule for the DHF system on a daily basis. The schedule will be produced in the afternoon (local time). The schedule will cover activities for the next seven operational days (an operational day is a 24 hour period). The schedule will be distributed to all DHF entities and also to the MMO. Refer to Figure 3.1.8-2 for a process flow diagram for this function.

Inputs to the schedule process include:

1. Wideband contact schedule from the MOC (via the LGS) for day 1 and day 2.
2. Wideband contact predicts for day 3 through day 7.
3. System access requests for
   a. training.
   b. system maintenance.
   c. testing.
   d. problem/anomaly investigation.
   e. configuration/quality audits.
   f. miscellaneous.

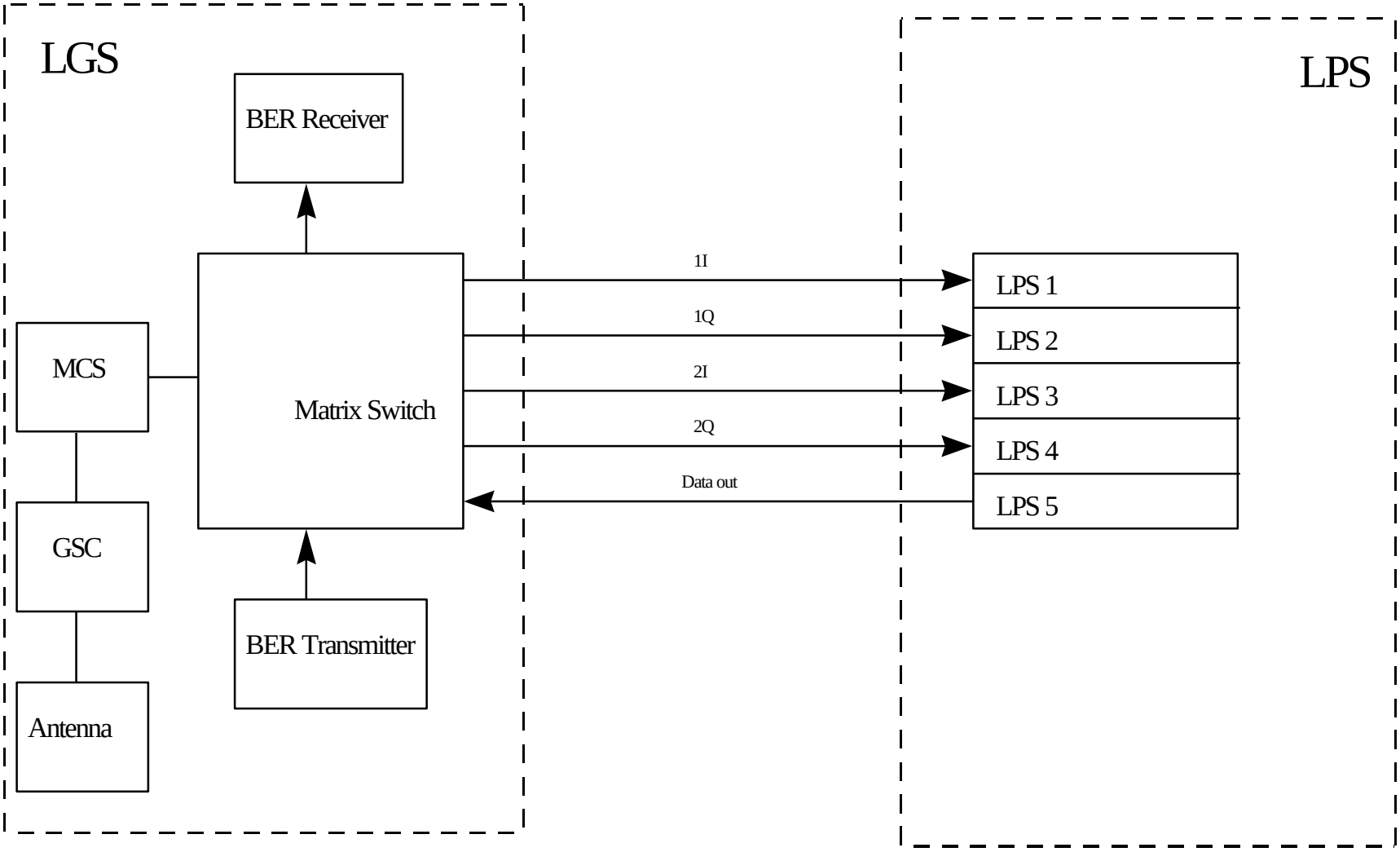


Figure 3.1.5-1. EDC DHF Operational Readiness Test Context Diagram

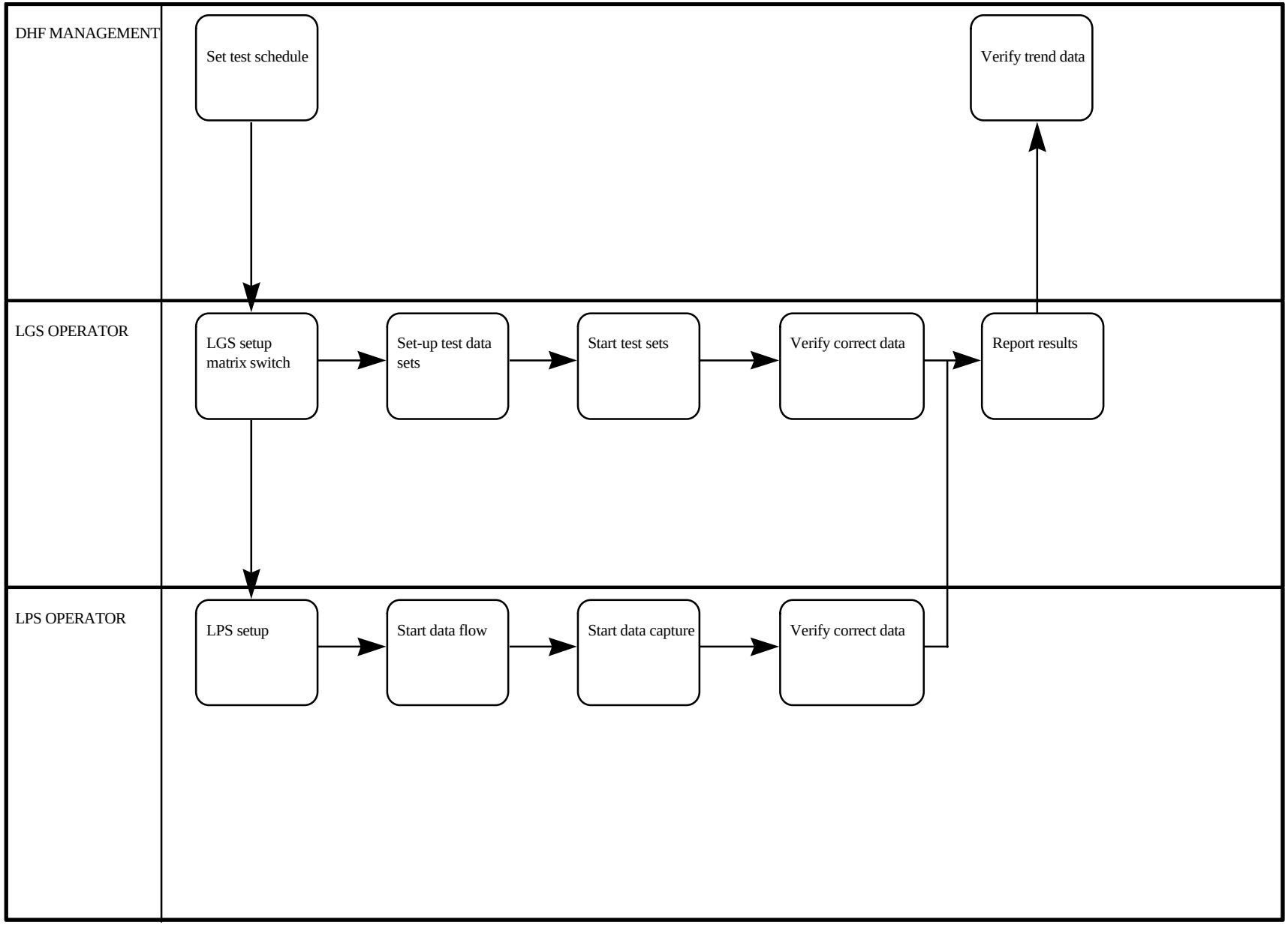


Figure 3.1.5-2. EDC DHF Operational Readiness Testing Process Flow Diagram

4. Level 0R reprocessing requests.
5. Supplemental site Level 0R processing requests.
6. Policy/guidelines/prioritization information from the DMO manager..
7. EDC DAAC operational status information.

The operations schedule produced by this process includes:

1. Identification of LGS/LPS/IAS operator coverage (by name).
2. Identification of primary processing events (wideband data capture, level 0R processing, image assessment) and when they will occur.
3. Identification of support events (testing, training, anomaly resolution, etc.) and when they will occur.
4. Identification of resources required (systems, personnel, ancillary equipment) to support scheduled activities.

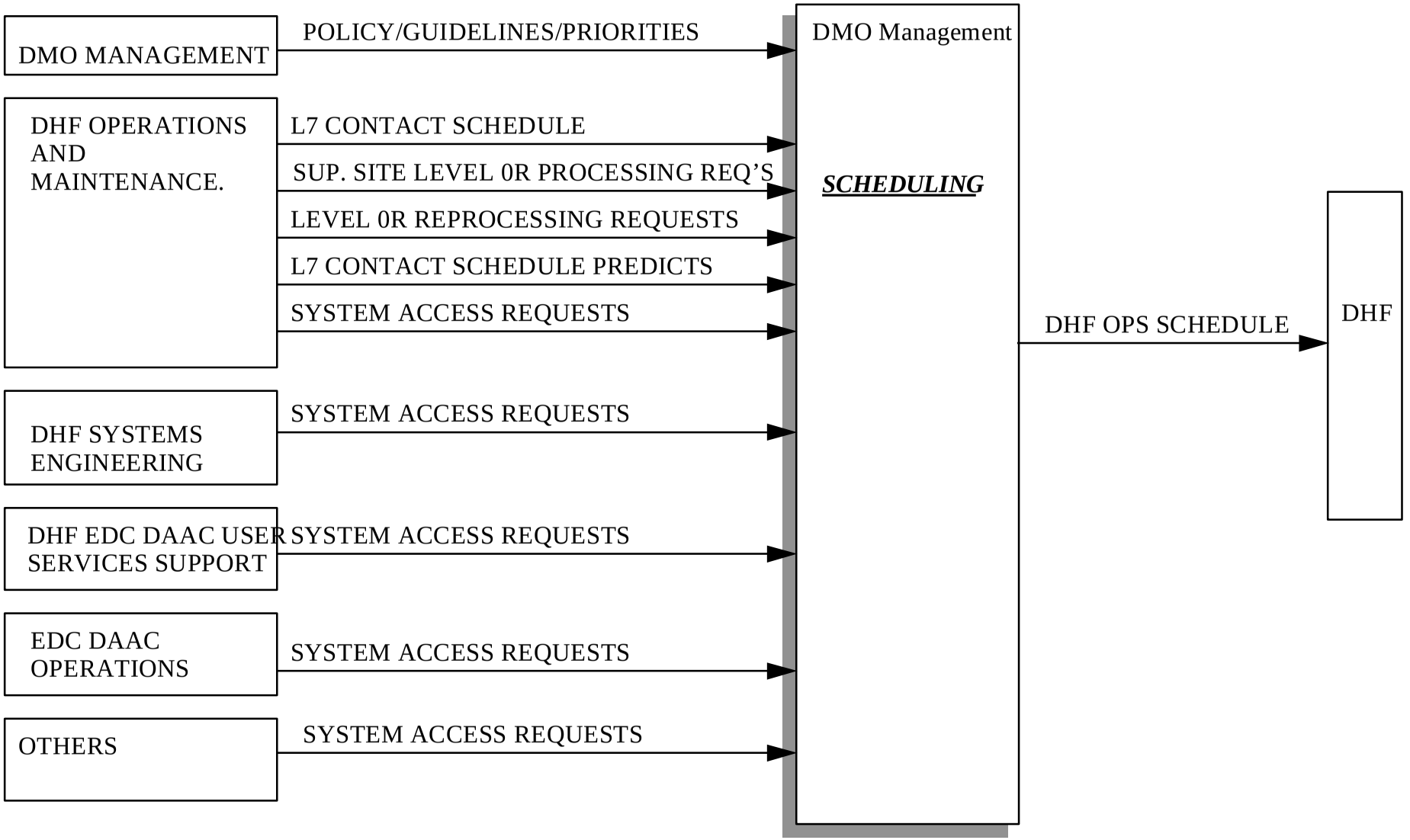


Figure 3.1.8-1. EDC DHF Operations Scheduling Context Diagram

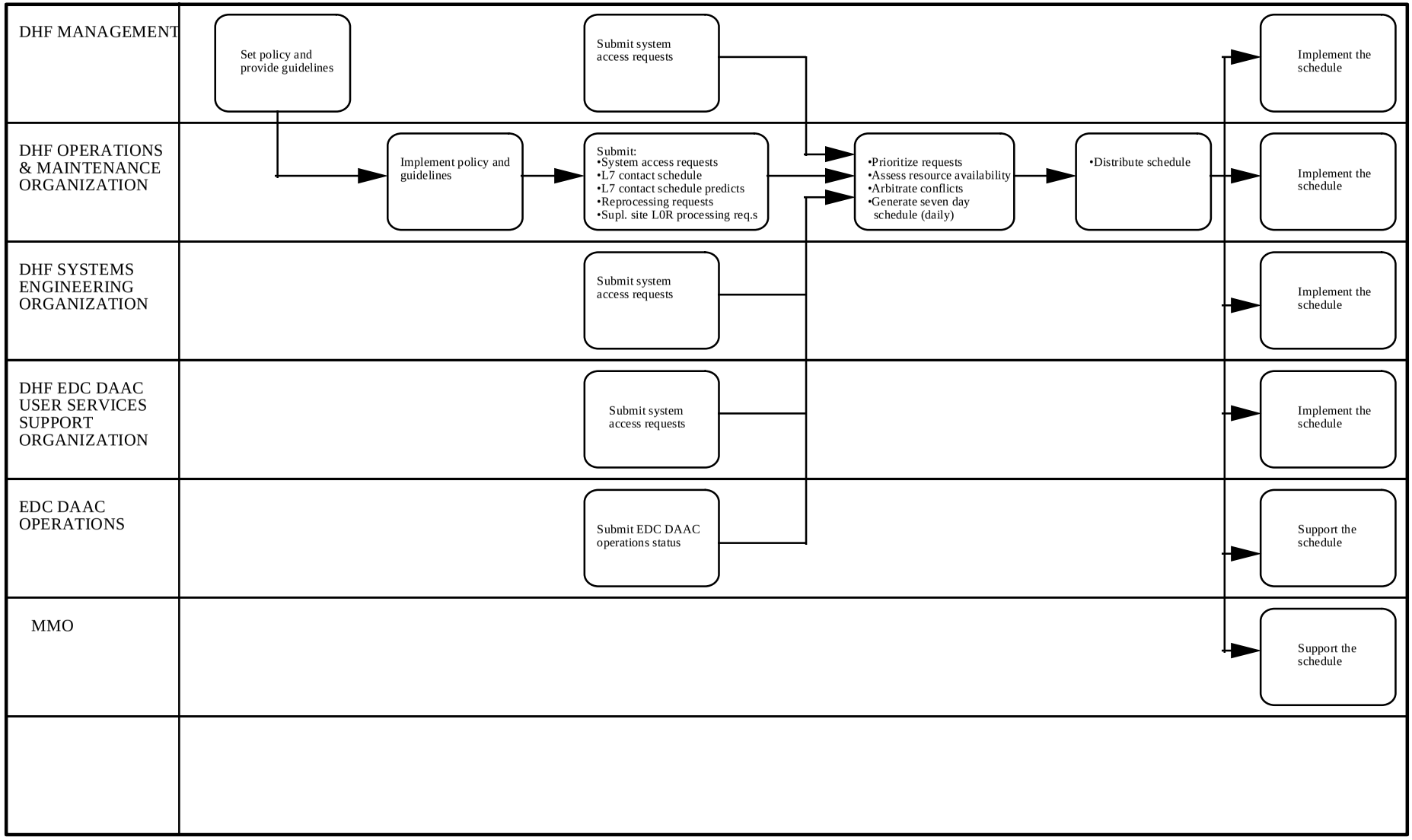


Figure 3.1.8-2. EDC DHF Operations Scheduling Scenario Process Flow Diagram

3.2 Contingency Operations

Procedures for contingency operations will be developed prior to launch and made available to DHF operations personnel. Contingency operations are initiated in response to a Landsat 7 system anomaly. Situations that will initiate contingency operations can be summarized as follows:

1. DHF equipment/internal interface failures and processing anomalies.
2. DHF external interface failures.
3. Failures of external Landsat 7 ground system elements.
4. Landsat 7 satellite or ETM+ instrument anomalies.

In those situations where no specific procedure has been identified, DHF operators will rely on experience and higher level policies and procedures to choose a course of action.

The DMO will inform other Landsat 7 ground system elements and the MMO that contingency operations have commenced. The DMO will provide the coordination and resources required to resolve the anomalies that initiated contingency operations.

Details of DHF contingency operations will be documented in DHF contingency plans and DHF operational procedures.

3.3 Backlog Processing

In the event that LPS becomes "backlogged" with more acquisitions than LPS can process and send to the DAAC, data will be processed on a Last-In/First-Out (LIFO) basis. The LPS will continue processing each pass as it occurs and sending appropriate messages to the DAAC. The backlog will be processed during the "slack" time, the time between pass sessions.

3.4 Priority Processing

Normal operations require immediate processing of real-time data so the only effect the DHF can exert on the overall timeliness of the process is to call the DAAC to ensure the priority data is ingested as quickly as possible. If the MOC notifies the DHF of a priority pass via E-mail or phone, the DHF will ensure timely processing of the priority pass and will alert the DAAC of the priority pass.

Section 4. DHF Operations Management

4.1 General

The EDC Data Handling Facility Management Office (DMO) will manage DHF operations. The DMO is a functional extension of the Landsat 7 Mission Management Office. The DMO is located at EDC.

4.2 Responsibilities

The DMO is responsible for the day to day operations of the DHF. Specifically, the DMO is responsible for:

a. Staffing operations, maintenance and related support services.
b. Configuration management of DHF systems.
c. Data quality assurance.
d. Training operations and maintenance staff.
e. Operational procedure development and maintenance.
f. EDC facility coordination.
g. Landsat 7 DHF sustaining engineering
h. Scheduling daily Landsat 7 DHF activities.
i. Anomaly resolution.

In addition to managing the day to day activities of the DHF, the DMO is responsible for managing the DHF interaction with external organizations. Specifically, the DHF manager is responsible for:

a. MMO Coordination.
b. MOC Coordination.
c. IGS browse and metadata ingest logistics coordination
d. EDC DAAC user services support.
e. Commercial vendor maintenance support coordination.
f. Landsat 7 anomaly resolution participation.

4.3 Organizational Structure

The functional structure of the DMO is shown in Figure 4-1. The DMO is divided into the following organizations:

1. DHF Management
2. Operations and Maintenance
3. System Engineering
4. EDC DAAC user services support

The roles and responsibilities of each of these organizations is shown in Figure 4-1. The interaction of these organization within the DMO is beyond the scope of this document.
The DMO will be staffed by USGS and contract personnel drawn from existing functional organizations at EDC on an as needed basis. In addition, some personnel may be hired specifically to support the DHF.

DMO operational details will be provided in the DHF Operations Support Plan.

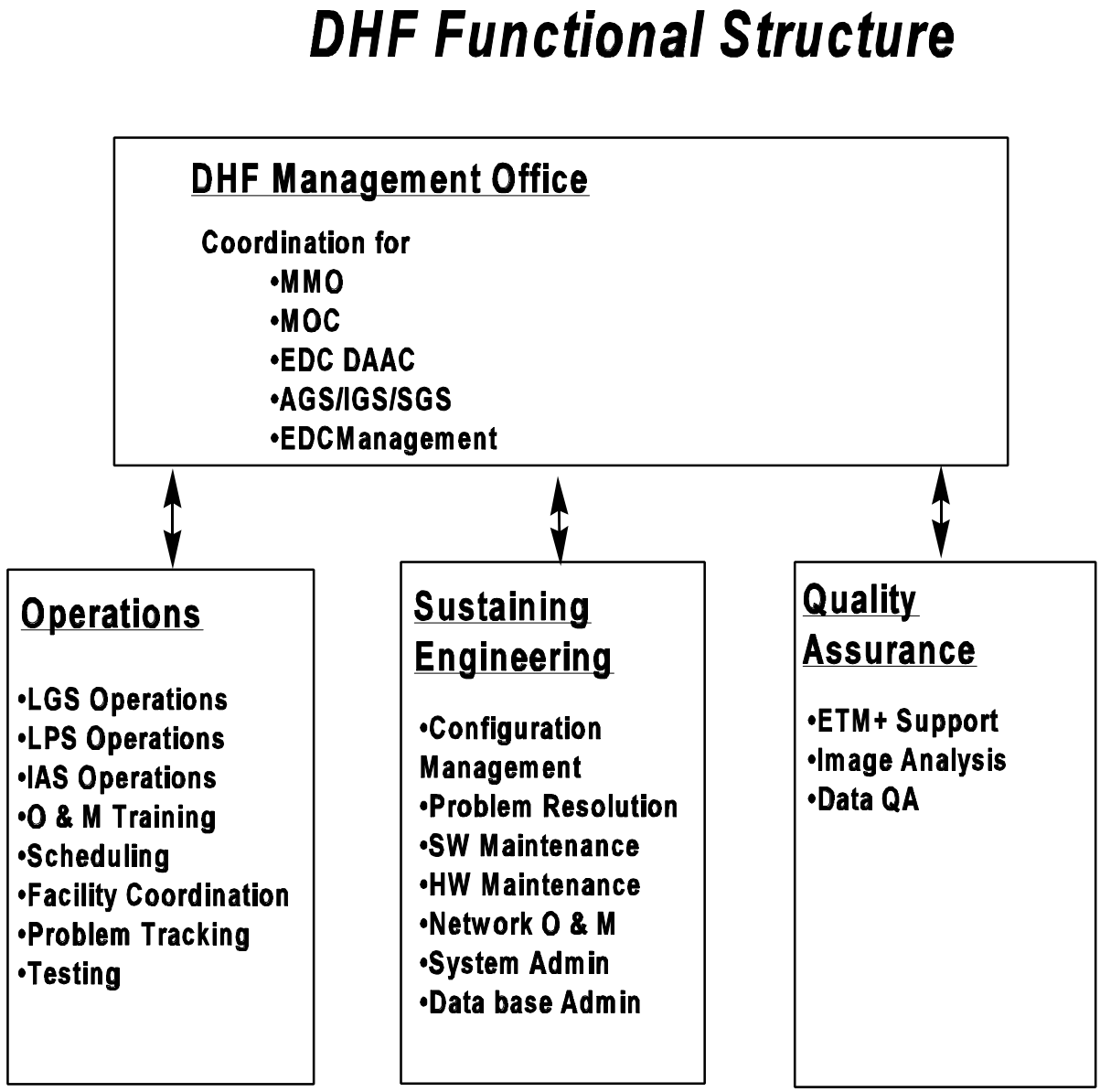
4.4 EDC DAAC Coordination

The EDC DAAC performs critical functions for the Landsat 7 project. The EDC DAAC functions as part of the DHF yet is not managed, operated, or maintained by the DMO.

The EDC DAAC provides the following services for Landsat 7:

1. Archives Landsat 7 ETM+ Level 0R data products.
2. Distributes data products to the Landsat 7 user community.
3. Performs billing and accounting functions..
4. Provides a comprehensive user services function.

The DMO will coordinate operations with the EDC DAAC to ensure that the EDC DAAC receives the Level 0R data, Landsat 7 program information and technical support required to service the Landsat 7 project.


DHF Functional Structure
DHF Management Office
Coordination for
•MMO
•MOC
•EDC DAAC
•AGS/IGS/SGS
•EDCManagement
Operations
•LGS Operations
•LPS Operations
•IAS Operations
•O & M Training
•Scheduling
•Facility Coordination
•Problem Tracking
•Testing
Sustaining Engineering
•Configuration Management
•Problem Resolution
•SW Maintenance
•HW Maintenance
•Network O & M
•System Admin
•Data base Admin
Quality Assurance
•ETM+ Support
•Image Analysis
•Data QA
Figure 4-1

Acronyms

AOS	Acquisition Of Signal
DAAC	Distributed Active Archive Center
DHF	Data Handling Facility
DMO	Data Handling Facility Management Office
EBnet	EOSDIS Backbone Network
ECS	EOSDIS Core System
EDC	EROS Data Center
DHF	EDC Data Handling Facility
EOSDIS	Earth Observing System Data and Information System
EROS	Earth Resources Observation Systems
ETM+	Enhanced Thematic Mapper Plus (instrument)
FDDI	Fiber Distributed Data Interface
Gbyte	Gigabyte
GN	Ground Network
GSC	Ground Station Controller
GSFC	Goddard Space Flight Center
GXA	Gimbaled X-band Antenna
HDF	Hierarchical Data Format
IAS	Image Assessment System
ICD	Interface Control Document
IRD	Interface Requirements Document
IGS	International Ground Station
LAN	Local Area Network
LGS	Landsat 7 Ground Station
LOE	Level-of-Effort
LPS	Landsat 7 Processing System
L0R	Level Zero Reformatted
MCS	Monitor and Control Subsystem
MMO	Mission Management Office
MOC	Mission Operations Center
MSCD	Mirror Scan Correction Data
MTPE	Mission to Planet Earth
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
O&M	Operations and Maintenance
PCD	Payload Correction Data
QA	Quality Assurance
QPSK	Quadrature Phase Shift Keying
RAID	Redundant Array Inexpensive Devices
RF	Radio Frequency
SGI	Silicon Graphics, Incorporated
SN	Space Network
TBD	To Be Defined/Determined
TBR	To Be Resolved
TBS	To Be Specified
UPS	Uninterruptible Power System
USGS	United States Geological Survey